Claims

1. A method for determining loss associated with a ferroelectric circuit component comprising:

fabricating a circuit comprising the ferroelectric component;

measuring an insertion loss due to the ferroelectric component;

determining components of the insertion loss that are due to other loss sources; and

removing the components due to other loss sources from the measured insertion loss to determine the loss associated with the ferroelectric component.

2. A method as claimed in claim 1, wherein the ferroelectric component is a gap capacitor.

3. A method as claimed in claim 2, wherein the circuit comprises an integrated structure including a resonator integrated with the gap capacitor.

4. A method as claimed in claim 3, the integrated structure comprises conductive strips deposited on a low

loss substrate separated by a gap, and a thin film of ferroelectric material underneath the gap.

5. A method as claimed in claim 1, wherein the ferroelectric component is selected from a group comprising an interdigital capacitor; a gap capacitor and an overlay capacitor.

6. A method as claimed in claim 1, wherein the circuit is a narrowband resonant circuit.

7. A method as claimed in claim 1, wherein the insertion loss due to the ferroelectric component is measured using a network analyzer.

8. A method as claimed in claim 1, wherein the components of the insertion loss that are due to other loss sources are determined using a circuit simulation tool.

9. A method as claimed in claim 1, wherein the components of the insertion loss that are due to

other loss sources are determined using a electromagnetic field simulation tool.

10. A method as claimed in claim 1, wherein the ferroelectric component has a Q greater than 100.

11. A method as claimed in claim 1, wherein the ferroelectric component has a Q greater than 200.

12. A method for determining the loss associated with a ferroelectric capacitor comprising:

fabricating a narrowband resonant circuit that integrates the ferroelectric capacitor;

measuring the center frequency and insertion loss of the circuit with a network analyzer;

analyzing the circuit on a circuit simulation tool to determine the components of the insertion loss due to conductive metal components of the resonant circuit and due to the geometry of the ferroelectric capacitor;

removing these components from the measured insertion loss to determine the loss due to the ferroelectric capacitor.

13. A method as claimed in claim 12, wherein the narrowband resonant circuit comprises a microstrip resonator having a gap to define the capacitor.

14. A tunable thin film ferroelectric device fabricated using a method that isolates the loss due to the ferroelectric film.

15. A tunable device as claimed in claim 14, wherein the device comprises a ferroelectric capacitor and a resonator.

16. A tunable device as claimed in claim 14, wherein the device comprises a planar, second order combline bandpass filter coupled to a lumped element, interdigital capacitor.

17. A tunable device as claimed in claim 14, wherein the device comprises a microstrip resonator having an integrated gap capacitor.

18. A narrowband resonant circuit having an integrated ferroelectric capacitor, the circuit being configured to permit accurate testing of the loss associated with the capacitor and to facilitate its use as a building block in a tunable circuitry component.

19. A narrowband resonant circuit comprising a microstrip resonator having an integrated gap capacitor, wherein the resonator comprises thin metal strips separated by a gap on a low loss substrate, the gap capacitor comprises a ferroelectric film deposited proximate the gap between the strips.

20. A narrowband resonant circuit as in claim 19, wherein the gap capacitor has a Q greater than about 100.

21 ~~20~~. A method of testing a tunable ferroelectric component configured to operate in a tunable frequency range comprising:

designing a resonant circuit configured to resonate in the tunable frequency range;

coupling the resonant circuit to the tunable ferroelectric component;

measuring the loss in the tunable ferroelectric component using the tunable circuit; and

determining non-ferroelectric sources of loss associated with the ferroelectric component to demonstrate that the ferroelectric loss associated with the component is acceptably low.

21. A tunable ferroelectric capacitor comprising:

a first conducting surface;

a second conducting surface, the first and second conducting surfaces comprising a capacitor;

a ferroelectric material proximate the first and second conducting surfaces;

a variable voltage line coupled to the ferroelectric material for changing a capacitance of the capacitor, responsive to a changing dielectric constant of the ferroelectric material, responsive to a voltage applied to the variable voltage line;

wherein a Q of the capacitor, when operated in a temperature range between about -50 degrees Celsius and 100

degrees Celsius, is greater than about 80 in a frequency range between 0.25 GHz and 7.0 GHz.

22. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 80 in a frequency range between about 0.8 GHz and 7.0 GHz.

23. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 80 in a frequency range between about 0.25 GHz and 2.5 GHz.

24. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 80 in a frequency range between about 0.8 GHz and 2.5 GHz.

25. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 180 in a frequency range between 0.25 GHz and 7.0 GHz.

26. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 180 in a frequency range between about 0.8 GHz and 2.5 GHz.

27. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 80 for a capacitance in a range between about 0.3 pF and 3.0 pF.

28. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees

Celsius, is greater than about 80 for a capacitance in a range between about 0.5 pF and 1.0 pF.

29. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 180 for a capacitance in a range between about 0.3 pF and 3.0 pF.

30. A tunable ferroelectric capacitor as in claim 21, wherein the quality factor, when operated in a temperature range between about -50 degrees Celsius and 100 degrees Celsius, is greater than about 180 for a capacitance in a range between about 0.5 pF and 1.0 pF.

31. A capacitor as claimed in claim 21, wherein the capacitor has a capacitance of about 0.8 to 1.5 pF when zero voltage is applied to the ferroelectric material.

32. A capacitor as claimed in claim 21, wherein the ferroelectric material comprises barium strontium titanate.

33. A capacitor as claimed in claim 21, wherein the ferroelectric material comprises a film having a thickness of approximately one micron.

34. A capacitor as claimed in claim 21, wherein the capacitor is a microstrip gap capacitor.

35. A capacitor as claimed in claim 26, wherein the first conducting surface and the second conducting surface are separated by a gap approximately 2.5 microns wide.

36. A capacitor as claimed in claim 21, wherein the conductors are metal strips having a thickness in the range of 2-3 microns.

37. A capacitor as claimed in claim 21, wherein the capacitor is an overlay capacitor.

38. A capacitor as claimed in claim 21, wherein the second conducting surface comprises either gold or silver.

39. A capacitor as claimed in claim 21 wherein:

a first taper to the ferroelectric capacitor from a ferroelectric capacitor bond pad comprises a contraction of the first conducting surface from about 4.0 mils wide to about 0.1 mils wide over a distance of about 1.0 mils; and

a second taper from the ferroelectric capacitor to a DC bias pad region comprises an expansion of the second conducting surface from about 0.1 mils wide to about 4.0 mils wide over a distance of about 1.0 mils.

40. A tunable ferroelectric filter comprising:

a first element having an inductance;

a second element having a capacitance, the first and second elements being electrically coupled in a filter configuration to produce a characteristic frequency;

a ferroelectric material positioned near either the first element or the second element; and

a control line coupled to the ferroelectric material for varying a dielectric constant of the ferroelectric material and the characteristic frequency;

wherein a Q of the tunable ferro-electric filter is greater than about 100.